

## **Canales-Mariner AB & LC4x4 Generalized Response and Calibration Factor**

These calculations are for the generalized case and assume the signal is in the sensor frequency range giving a flat response. Frequency response ranges are indicated.

### SENSOR RESPONSE INFO:

For the High-Tech Hydrophone sensitivity:

For the custom High-Tech Hydrophone (HTI-90-U) the manufacturer calibration files give a sensitivity of -182.7 dB re 1V/ $\mu$ Pa. This hydrophone loses ~2 dB in sensitivity per ~6000m in depth (10,000 psi) so for typical ocean depth around 3km we correct ~1 dB and use -183.7 dB re 1V/ $\mu$ Pa. Using amplitude spectra throughout (e.g.  $X[\text{db}] = 20 \cdot \log_{10}[X/X_{\text{ref}}]$ ), this gives  $S(\text{hyd-HTI}) = 10^{**(-183.7/20)} \cdot 1\text{V}/\mu\text{Pa} = .653 \text{ mV}/\text{Pa}$  (@ 3000m water depth). Thus:

**$S(\text{hyd-HTI}) = 0.653 \text{ mV}/\text{Pa}$  -or-  $(6.53\text{e-}4 \text{ V}/\text{Pa})$**

*flat response: 0.05 Hz to 7.5 kHz (@ 3000m depth)*

Frequency response information:

From Brian Spychalski at High Tech Inc. (personal communication: June 03, 2014):

1: HPF at input of preamp created by ceramic element 12.8nF (nom.) and 300 meg ohm resistor (0.04Hz)

2: There is another HPF at opamp set at 0.02Hz.

3: LPF at opamp is set at 7.5KHz.

<b>Parameter</b>	<b>Nominal Value</b>	<b>Units</b>
Zeros (2)	0 0	Rad/s
Poles (3)	-24.127431 -0.1256637 -47124	Rad/s
Normalization	47124	
Normalization Frequency	500	Hz

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For the L28LB tri-axial seismometer sensitivity:

Transduction constant -->  $1.57 * \sqrt{R\text{-coil}}$  V/m/s with R-coil = 630 ohm nominally this gives 39.53 V/m/s. SIO uses 70% coil current damping, (R-shunt-ss = (7860+51) ohm single-sided, divide by 2 to effective R-shunt damping for differential signal), thus R-shunt-diff = 3956 ohm, which gives:

**S(L28) = 34.10 V/m/s** *flat response: ~4.5 Hz and above*

Frequency response information (for a damped oscillator):

Two zeros at 0, two poles at  $\omega_0 \left( \delta \pm i\sqrt{1-\delta^2} \right)$  where  $\delta = 0.701$  (damping value).

Parameter	Nominal Value	Units
Zeros (2)	0 0	Rad/s
Poles (2)	19.820 +/- i*20.164	Rad/s
Normalization	-1	
Normalization Frequency	4.5	Hz

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For the L22D vertical seismometer sensitivity:

Transduction constant -->  $1.61 * \sqrt{R\text{-coil}}$  V/m/s with R-coil = 510 ohm nominally this gives 36.36 V/m/s. SIO uses 60% coil current damping, (R-shunt-ss = (7860+51) ohm single-sided, divide by 2 to effective R-shunt damping for differential signal), thus R-shunt-diff = 3956 ohm, which gives:

**S(L22) = 32.21 V/m/s** *flat response: ~2.0 Hz and above*

Frequency response information (for a damped oscillator):

Two zeros at 0, two poles at  $\omega_0 \left( \delta \pm i\sqrt{1-\delta^2} \right)$  where  $\delta = 0.599$  (damping value).

Parameter	Nominal Value	Units
Zeros (2)	0 0	Rad/s
Poles (2)	7.527 +/- i*10.063	Rad/s
Normalization	-1	
Normalization Frequency	2.0	Hz

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ELECTRONICS RESPONSE INFO:

The sensitivity of the A/D is as follows:

With reference filter voltage of V-filt = 100 ohm the voltage range is +/- 2.47 V,

max counts over this range are -Vref = -6,100,300 to +Vref = 6,102,081.

This gives  $S(a/d) = 4.94 / 12,202,381 = 0.405 \times 10^{-6} \text{ V/count} = 0.405 \text{ microV/count}$ , or:

**S(a/d) = 0.405  $\mu\text{V/count}$  -or- (4.05e-7 V/count)**

*Note: A/D reaches full 24-bit range (i.e. -8388608 to 8388607) @ overvoltage of +/- 3.3 V. However, the response in this overvoltage range is roughly nonlinear.*

*Note2: If V-filt = 10 ohm the voltage range is +/- 2.50 V  $\rightarrow$   $S(a/d) = 0.410 \text{ microV/count}$ .*

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PRE-AMP GAIN INFO:

Pre-amp gain settings for sensor/channel on OBS deployments were:

**gain(hyd-HTI) = 16**

**gain(L28) = 64**

**gain(L22) = 64**

TOTAL SYSTEM RESPONSE INFO:

Total system response then becomes:  $S(\text{total}) = S(a/d)/[S(\text{sensor})*\text{gain}]$

**AB & LC4x4 Generalized Total System Response:**

**AB-SP (4-comp) units:**

**Hydro-HTI pressure response = 38.76  $\mu\text{Pa/count}$  (~0.05 Hz to 7.5 kHz)**  
**= 3.876e-5 Pa/count**

**L28 Velocity response = 0.186 (nm/s)/count (~4.5 Hz and above)**  
**= 1.86e-10 (m/s)/count**

**LC4x4-SP (2-comp) units:**

**Hydro-HTI pressure response = 38.76  $\mu\text{Pa/count}$  (~0.05 Hz to 7.5 kHz)**  
**= 3.876e-5 Pa/count**

**L22 Velocity response = 0.196 (nm/s)/count (~4.5 Hz and above)**  
**= 1.96e-10 (m/s)/count**